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Thyroidectomy Using Monitored Local or Conventional General Anesthesia: An Analysis of Outpatient Surgery, Outcome and Cost in 1,194 Consecutive Cases

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Abstract
Background: Critical appraisal of safety, feasibility, and economic impact of thyroidectomy procedures using local (LA) or general anesthesia (GA) is performed.
Methods: Consecutive patients undergoing thyroidectomy procedures were selected from a prospective database from January 1996 to June 2003 of a single-surgeon practice at a tertiary center. Statistical analyses determined differences in patient characteristics, outcomes, operative data, and length of stay (LOS) between groups. A cohort of consecutive patients treated in 2002–2003 by all endocrine surgeons at the institution was selected for cost analysis.
Results: A total of 1,194 patients underwent thyroidectomy, the majority using LA (n = 939) and outpatient surgery (65%). Female gender (76%), body mass index ≥30 kg/m^2 (29%), median age (49 years), and cancer diagnosis (45%) were similar between groups. Extent of thyroidectomy (59% total) and concomitant parathyroidectomy (13%) were similarly performed. GA was more commonly utilized for patients with comorbidity [15% vs. 10%, Anesthesia Society of America (ASA) ≥3; $P < 0.001$], symptomatic goiter (13% vs. 7%; $P = 0.004$), reoperative cases (10% vs. 6%; $P = 0.01$), and concomitant lymphadenectomy procedures (15% vs. 3%; $P < 0.001$). GA was associated with significant increase in LOS ≥24 hours (17 % vs. 4%) or overnight observation (49 % vs. 14%), $P < 0.001$. Operative room utilization was significantly associated with type of anesthesia (180 min vs. 120 min, GA vs. LA, $P < .001$) and impacted to a lesser degree by surgeon operative time (89 minutes vs. 76 minutes, GA vs. LA; $P = .089$). Overall morbidity rates were similar between groups (GA 5.8 % vs. LA 3.2%). The actual total cost (ATC) per case for GA was 48% higher than for LA and 30% higher than the ATC for all procedures ($P = 0.006$), with the combined weighted average impacted by more LA cases (n = 217 vs. 85).
Conclusion: These data from a large, unselected group of thyroidectomy patients suggest LA results in similar outcomes and morbidity rates to GA. It is likely that associated LA costs are lower.

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We previously reported the safety and feasibility of thyroidectomy using local anesthesia (LA) in 1,025 patients and established its utility in a wide range of patients considered for a vast array of thyroid procedures.[1] LA procedures were accomplished in patients with high comorbidity scores (10%) and those requiring more extensive or complex resections with overall low associated morbidity. Same-day discharge was achieved in 80% of patients and in 96% by 23 hours. Intuitively, one might anticipate several advantages to thyroidectomy performed using LA when compared with conventional general anesthesia (GA) with regard to length of hospital stay, operating room utilization, cost containment, patient selection, and voice monitoring. Since thyroidectomy using LA is uncommonly utilized by contemporary endocrine surgeons,[2–10] studies directly comparing this method to conventional GA are lacking. Published comparative studies are impacted by small cohort size and stringent patient selection bias with limited or no comparative cost data available.[5,9] Cost analyses for thyroidectomy procedures performed in the USA have been limited to studies of outpatient surgery that have addressed results using GA methods only.[11–14] Furthermore, since overall operative morbidity, specifically recurrent nerve injury, is low for thyroidectomy procedures, a large cohort of unselected patients is needed to determine potential advantages of thyroidectomy performed with voice monitoring in an awake patient, a unique feature of thyroidectomy using LA, which distinguishes this method from a GA approach.[15,16]

This study was conducted to compare thyroidectomy performed using LA to standard, conventional GA in a large number of unselected patients with outcome measures including patient characteristics, operative data, morbidity, length of stay (LOS), and cost. Clinically meaningful differences in the types of patients, procedures, and outcomes associated with each thyroidectomy approach are described.

MATERIALS AND METHODS

Patient Selection and Type of Anesthesia

Consecutive patients undergoing thyroidectomy procedures at Columbia University Medical Center by a single surgeon (PL) from January 1996 to June 2003 were selected for study. During this period, LA was routinely offered to all eligible patients undergoing thyroidectomy. Patients with known extensive substernal, retrotracheal/esophageal goiter, locally advanced or regional thyroid cancer, documented recurrent nerve dysfunction, allergy to LA, language barrier, or inability to communicate with the operating team were not eligible for a local procedure. Local thyroidectomy procedures were accomplished using a regional, combined superficial and deep C2–C4 cervical block with lidocaine and bupivicaine LA with the patient under monitored intravenous sedation, as described in previous publications.[1,17,18] Patients who did not choose or were not eligible for LA technique underwent conventional thyroidectomy with GA and endotracheal intubation. A similar regional cervical block was performed on GA patients for intra- and perioperative pain control.

Thyroidectomy Procedures

A modified surgical approach with regard to incision placement and cervicotomy closure has been previously published in detail and was employed for all patients in this study, regardless of the anesthetic method.[17,18] Modifications include a transverse incision placed high on the neck at the level of the cricoid cartilage, allowing access to the relatively fixed superior pole vessels. Cervicotomy closure involves interrupted approximation of strap muscles overlying the cricoid cartilage and leaving the lower strap muscles open for decompression should perioperative hematoma occur. A clear Collodion adhesive dressing placed on the skin incision facilitates sutureless, cosmetic closure and ability to easily monitor the wound in the postoperative period.[16] In addition, vessels were hemostatically controlled with 2.0 and 3.0 silk ties. The recurrent laryngeal nerve (RLN) was identified in each case. Nerve monitoring involved phonation during LA thyroidectomy procedures. No specific nerve monitoring devices were used during thyroidectomy performed under GA.

Perioperative Patient Management

As a routine, all patients were monitored postoperatively in a recovery room setting for 6 hours. Perioperative procedures included nonnarcotic analgesia, calcium prophylaxis (± vitamin D therapy) in patients at risk for hypoparathyroidism, and patient education by specialized staff. Following a 6-hour recovery period, patients eligible for same-day surgery were evaluated by the surgeon for potential discharge. If all criteria were met, patients were discharged following the 6-hour observation period regardless of anesthesia method. Those who did not meet criteria or who required continued monitoring were admitted for a 23-hour observation or a longer hospital stay, as deemed necessary by the surgeon.[15,16,19,20]

Statistics and Cost Analysis

Data collection and review were conducted with approval from Columbia University Medical Center Institutional Review Board. Patient demographics, operative details, perioperative complications, and LOS data were collected and analyzed using descriptive statistics (SPSS, Version 10.0, Chicago, IL, USA). A comparative analysis was performed for patients grouped according to type of anesthesia (locoregional or general endotracheal) on an intent-to-treat basis. Significance was defined as a *P* value <0.05 based on Fisher's exact test for discrete variables and Kruskal–Wallis test for continuous variables. LOS was divided into 3 categories: outpatient (6-hour observation), discharged by <24 hours, and discharged ≥24 hours.

A separate cohort of patients was selected for cost analysis. Patients undergoing consecutive thyroidectomy procedures at the New York Thyroid Center by surgeons with a focus in endocrine surgery during the years 2002–2003 were selected for further review. ATC data associated with each of the 302 consecutive cases were assembled using the hospital's cost accounting support system. These data included both fixed and variable technical costs for each procedure: operating and recovery room, pharmacy, equipment, nursing, and room and board but not professional fees. Mann–Whitney test was used to compare the mean ATC and variance between patients undergoing thyroidectomy with LA and GA. Adjustments for possible factors such as extent of thyroidectomy procedure, LOS, and operating room time were made by combining *P* values across different levels of these factors, with significance defined as a *P* value <0.05.

RESULTS

Patient Characteristics and Operative Procedures

In this 8-year study, 1,194 patients underwent thyroidectomy procedures with the majority (n = 939/1194, 79%) performed using LA. Following initial safety and feasibility trials in a selected cohort of patients from 1987–1993,[19,20] LA thyroidectomy eligibility criteria were broadened in 1996 to include nearly all patients presenting for thyroidectomy.[1,15,16] This selection bias reflects the significant increase in the proportion of local procedures compared with general cases that occurred throughout the course of the study (Fig. 1).

Table 1 summarizes clinical features of patients undergoing the 2 operative approaches. Female gender (76%) and age (49.5 years; range 7–89) were similar

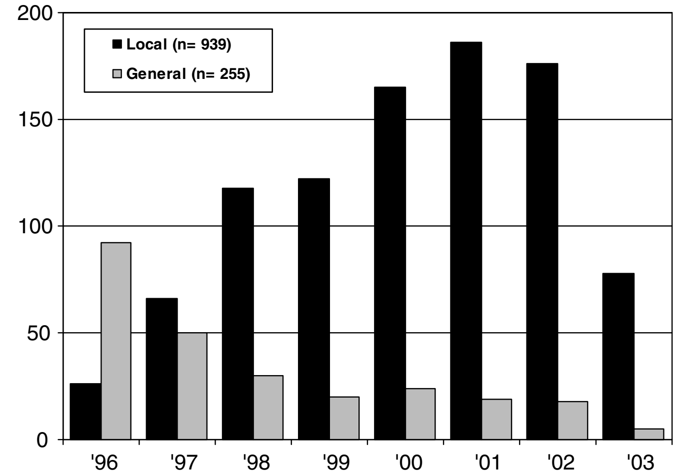

Figure 1. Comparison of the number of consecutive thyroidectomy procedures performed from 1996–2003 by a single surgeon (PL) at the New York Thyroid Center using local or conventional general anesthesia ($P < 0.001$). Adapted with permission from Spanknebel *et al.*[1]

between LA and GA groups and reflective of other large thyroidectomy series.[21–26] In spite of broadened selection criteria, however, GA was more commonly utilized in patients with increased comorbidity, as described by higher Anesthesia Society of America (ASA) scores of 3 and 4 (16% vs. 11%, GA vs. LA, $P < 0.001$). Available data quantifying patient body habitus showed a similar proportion of obese patients in each of the patient groups (GA 54% and LA 46%, $P = 0.10$). A trend was noted, however, toward more malignant conditions addressed using LA (47% vs. 46%, $P = 0.03$). This was likely due to shifts in pathological diagnosis and patient selection rather than clinically meaningful differences related to technique.

Comparative analysis of operative data demonstrated important differences between LA and conventional thyroidectomy groups depicted in Table 2. Since patients with preoperatively identified substernal or retrotracheal/esophageal goiter were typically not offered the LA thyroidectomy, it is not surprising that more patients underwent extensive goiter resections using GA (13% vs. 7%, $P = 0.004$). Likewise, patients with known regional thyroid cancer requiring cervical lymphadenectomy procedures were more frequently handled using a conventional GA approach (15% vs. 3%, $P < 0.001$). Prior neck surgery was not a contraindication to LA thyroidectomy; however, more reoperative procedures were performed using GA (10% vs. 6%; $P = 0.01$). This was also the case for extensive bilateral procedures, including total and subtotal thyroidectomy, which were the types of procedures more commonly performed using GA (63% vs. 61%; $P = 0.005$). Concomitant parathyroidectomy was similarly performed using either approach in 13% of cases.

Table 1.
Comparison of patient demographics and thyroid pathology for 1,194 procedures performed from January 1996 to June 2003 according to the type of anesthesia used

Feature	General anesthesia	Local anesthesia	*P*
Number of patients	255	939	—
Female (%)	74	79	0.08
Ratio	2.8:1	3.8:1	
Age in years			
Median (range)	49 (7–85)	50 (13–89)	0.05
Mean	48	50	
ASA class (%)[a]			
1	38 (17)	74 (9)	<0.001
2	146 (67)	664 (80)	
3	34 (15)	79 (10)	
4	1 (1)	7 (1)	
[a]Obese; BMI ≥30 kg/m^2 (%)	94/174 (54)	203/438 (46)	0.10
Pathology (%)			
Benign (includes adenoma)	134 (54)	466 (53)	0.03
Malignant	114 (46)	422 (47)	

ASA: Anesthesia Society of America; ASA1: healthy patient; ASA2: patient with mild systemic disease; ASA3: patient with severe systemic disease that limits activity but is not incapacitating; ASA4: patient with an incapacitating systemic disease that is a constant threat to life; BMI: body mass index.
[a]Some patient data are not available.

Table 2.
Summary of operative procedures and outcomes with comparative analysis according to the method of thyroidectomy

Variable	General anesthesia n = 255	Local anesthesia n = 939	*P*
Extent of thyroidectomy (%)			
Lobe	94 (37)	366 (39)	0.005
Total or subtotal	161 (63)	573 (61)	
Thyroidectomy performed with concomitant related procedure (%)			
Lymphadenectomy	37 (15)	24 (3)	<0.001
Parathyroidectomy	32 (13)	122 (13)	ns
Symptomatic goiter ≥60 g (%)	31 (13)	61 (7)	0.004
Prior neck surgery (%)	26 (10)	53 (6)	0.01
Surgeon operative time in minutes			
Mean (±SD)	89 (±47)	76 (±27)	0.089
Median (range)	73 (20–80)	73 (25–225)	
[a]Length of hospital stay			
Outpatient (6-hour observation)	75 (34)	703 (82)	
< 24 hours	108 (49)	124 (14)	<0.001
≥ 24 hours	39 (17)	33 (4)	

SD: standard deviation.
[a]Some patient data are not available.

Outcomes: Operative Duration and Length of Stay

There were no demonstrable differences in surgeon operative time as measured from skin incision to closure, with a mean of 89 minutes for GA procedures (range 20–280) and 76 minutes for LA procedures (range 25–225), $P = 0.09$ (Table 2). A more clinically meaningful and accurate comparison of operating room utilization is expressed as overall operating room duration that also includes anesthesia time. These data were available for a smaller subset of cases performed during 2002–2003 and are reported within the context of cost analysis below (Table 3). In fact, GA cases were associated with significantly increased mean operating room times compared with LA cases (180 vs. 120 minutes, GA vs. LA, *P* <

Table 3.
Comparative cost analysis and variance according to the type of anesthesia adjusted for possible factors associated with mean actual total cost

Factor	General anesthesia			Local anesthesia			*P*
	Number	ATC (SD)	Percent Δ ATC	Number	ATC (SD)	Percent Δ ATC	
Total	85	4,412 (2,300)	48	217	2,974 (1,346)	33	**0.006
Extent of procedure							
Unilateral thyroidectomy	24	3,731 (2,210)	30	71	2,862 (1,490)	23	*<0.001
Bilateral thyroidectomy	54	4,596 (2,179)	54	128	2,990 (1,317)	35	
Thyroidectomy and concomitant procedure	7	5,326 (3,198)	61	18	3,303 (871)	38	
Length of stay							
6-hour observation	42	3,153 (1,380)	14	188	2,760 (1,113)	12	
≤24 hours	41	5,542 (2,316)	27	29	4,362 (1,846)	34	*0.023
>24 hours	2	7,701 (3,335)	—	0	0 (0)	0	
Operating room cost	85	2,434 (1,467)	70	217	1,433 (645)	41	**<0.001
per minute room utilization		11.35 (4.08)[a]			11.42 (1.95)[b]		***<0.001

ATC: average actual total cost in US dollars; SD: standard deviation.
**P* values obtained with adjustments for types of procedure and length of stay by combining *P* values.
***P* value obtained without adjusting for other factors using Mann–Whitnev test.
****P* value obtained using two-sided permutation test on the ratio of the SD of the 2 groups.
[a]Median operating room duration 180 minutes for general anesthesia cases.
[b]Median operating room duration 120 minutes for local anesthesia cases.

0.001), most likely as a result of increased anesthesia time required for GA cases.

For the purposes of comparative analysis of discharge data, outpatient status was considered any hospital stay whereby patients were observed for 6 hours postoperatively and then discharged. Inpatient status was defined as any hospital stay more than 6 hours (23-hour overnight observation or hospital admission ≥24 hours). Figure 2A and B depict the trends in outpatient status during the course of the study for LA and GA patients, respectively. Within the context of a mature outpatient thyroidectomy program, both LA and GA patients enjoyed the possibility of shorter hospital stays. LA patients were more likely to receive short-stay procedures ($P = 0.001$), with 86% of patients discharged following 6-hour observation by the last 2 years of the study. (Figure 2A). In contrast, there were no particular trends noted for the GA group, where patients achieved outpatient status 0%–52% of the time on any given year during the 8 years of the study. (Figure 2B) Overall, significantly more LA patients were able to undergo short-stay procedures compared with the GA group (82% vs. 34%, $P < 0.001$).

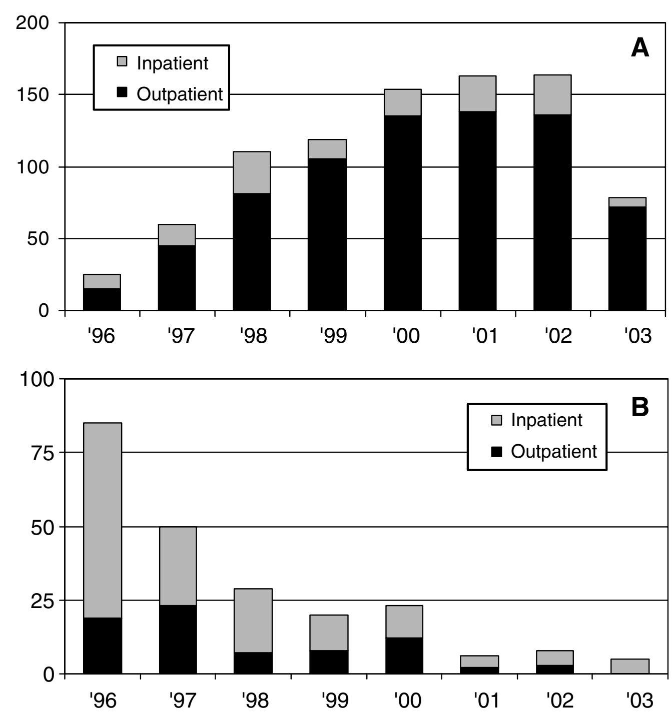

Figure 2. Number of patients undergoing thyroidectomy each year as inpatient (≤24 hours or >24 hours) or outpatient (6-hour observation) procedures using local (LA) (**A**) or general (GA) (**B**) anesthesia. **A**. Outpatient status increased significantly throughout the duration of the study for LA thyroidectomy patients, $P = 0.001$ (n = 860). **B**. There were no significant trends in early discharge status noted for patients undergoing conventional GA thyroidectomy procedures (n = 222).

Operative Complications

A critical appraisal of the types of complications seen for each of the operative approaches was performed (Table 4). The crossover rate to a GA approach (attempted

Table 4.
Comparative analysis of operative events and complications according to the method of thyroidectomy

Complication or operative event	General anesthesia n = 255	Local anesthesia n = 939	*P*
Recurrent laryngeal nerve injury (%)			
Temporary	4 (1.6)	16 (1.7)	0.90
Permanent (unintended injury)	2 (0.8)	7 (0.7)	0.73
Intentional nerve resection	4 (1.6)	3 (0.3)	0.20
Hematoma requiring therapy (%)	4 (1.6)	4 (0.4)	0.12
Permanent hypoparathyroidism (%)	0	1 (0.1)	0.48
Emergent tracheostomy (%)	1 (0.4)	1 (0.1)	0.90
Wound infection (%)	1 (0.4)	1 (0.1)	0.90
Chylous leak (%)	1 (0.4)	0	0.48
Tracheal perforation (%)	1 (0.4)	0	0.48
Readmission (%)	1 (0.4)	0	0.48
[a]Total (%)	15 (5.8)	30 (3.2)	0.12

[a]Calculation of overall complication event rate excludes intentional nerve resection

local cases that required conversion to GA) was low and did not significantly impact overall morbidity data (3.4%, n = 32). Reasons for conversion to GA are detailed in a previous publication.[1] Combined morbidity rates were comparable between the 2 groups: 5.5% for GA patients and 3.2% for LA patients; $P = 0.12$. There were no deaths.

More specifically, low RLN injury rates were seen (as calculated per patient) and did not appear to be impacted by the thyroidectomy approach used. A diagnosis of RLN injury was secured by performing direct fiberoptic naso-laryngoscopy in patients with noted voice changes or voice complaints. Systematic vocal cord exam was not routinely performed postoperatively but was, rather, prompted by symptomatic patients only. Temporary and permanent RLN injury occurred in 1.6% (n = 4) and 0.8% (n = 2) of patients who underwent conventional thyroidectomy, respectively. Similar rates of temporary (1.7%, n = 16) and permanent (0.7%, n = 7) RLN injury occurred in local thyroidectomy procedures. There were more intentional nerve resections, though not statistically significant, due to locally advanced malignancy in the GA group, which is reflective of the types of cases selected for a conventional approach (1.6% vs. 0.3%; $P = 0.20$).

Four neck hematomas requiring intervention occurred for each of the 2 groups, resulting in rates of 1.6% for GA and 0.4% for LA patients; $P = 0.12$. In patients undergoing LA thyroidectomy; postoperative neck swelling became apparent within the 6-hour observation period, with early exploration performed under LA. No patient experienced airway compromise, and bleeding was either superficial or deep to the strap muscles in each of 2 cases. Conventional thyroidectomy patients experienced postoperative hematoma at 5 hours (2 patients), 2 days, and 5 days from the surgical procedure. Of the 2 patients who bled at 5 hours postoperatively, 1 underwent reexploration using LA, with mild, nonspecific oozing noted in the subplatysmal area. The second patient had undergone extensive substernal goiter resection and required transfusion for coagulopathy and significant bleeding from a closed suction drain placed at the time of procedure. Following this therapy bleeding subsided, and no operative intervention was necessary. Both patients with delayed hematoma underwent resection of substernal goiters and had cardiac comorbidity requiring anticoagulation or antiplatelet therapy. The hematoma at 2 days occurred in a patient monitored as an inpatient during reinstitution of heparin therapy. No specific bleeding site was identified at re-exploration. The last patient who experienced a large hematoma with a rapid onset at 5 days postoperatively was found to have a bleeding superior pole arterial vessel from a slipped tie, with decompression of hematoma into the subplatysmal and subcutaneous tissue plains and no associated respiratory problems prior to definitive operative exploration. This patient accounted for the one readmission required in this study.

Hypoparathyroidism was a rare event, occurring in only 1 LA patient undergoing resection of malignancy and in no GA patient. Temporary hypoparathyroidism was not reported since postoperative calcium (± vitamin D) therapy was used routinely in at-risk patients, and hypocalcemic symptoms were likely underreported or of no clinical significance. Emergency tracheostomy was necessary in 1 GA patient for tracheal compression and narrowing due to massive goiter and in 1 LA patient as a result of inadvertent nerve injury during goiter resection with respiratory compromise. Unique complications occurred in GA patients associated with locally advanced cancer resection and included tracheal perforation (n = 1) and chylous leak (n = 1).

Cost Analysis

Table 3 shows cost data for 302 consecutive patients undergoing thyroidectomy procedures using LA (72%, n = 217) or GA (18%, n = 85) during years 2002–2003 by surgeons (n = 5) with a focus in endocrine surgery at Columbia University Medical Center. Overall, there was an appreciable difference in mean ATC for local ($2,974) and general procedures ($4,412), $P = 0.006$, with the combined mean ATC per case heavily impacted by a higher volume of LA thyroidectomy procedures (ratio = 2.6:1). The mean ATC for a GA procedure is 48% higher than for an LA case and 30% higher than the ATC per case for all procedures combined. Conversely, the ATC for an LA procedure is 33% lower than that for a conventional GA thyroidectomy and 12% lower than the ATC per case for LA and GA procedures combined.

A comparison of the 2 approaches adjusted for factors possibly associated with cost demonstrate that extensive procedures and increased operating room times were associated with the highest mean ATC per case; $P < 0.001$. For thyroidectomy performed with concomitant procedures or bilateral thyroidectomy under GA, costs were 54%–61% higher than for the same types of cases performed using LA. Furthermore, unilateral procedures were associated with a 23% lower mean ATC using LA ($2,862) compared with GA ($3,731). Operating room duration significantly impacted mean ATC for each group. The calculated ATC per minute operating room utilized was $11.35 for GA and $11.42 for LA procedures. ATC was impacted by longer room times for thyroidectomy using GA compared with LA (median 180 vs. 120 minutes; $P < 0.001$) and the greater predictability of operating room utilization for LA procedures [ATC per minute room utilization standard deviation (SD): $4.08 vs. $1.95, GA vs LA, respectively; $P < 0.001$]. When outpatient status was achieved, the ATC per case was only 14% higher for conventional GA thyroidectomy compared with LA thyroidectomy and 27% higher when patients were admitted for overnight observation, $P = 0.023$. (Table 3).

DISCUSSION

Patient Selection

Since LA rapidly became the preferred method for performing thyroidectomy at our institution with its broad application to a majority of patients from 1996,[1,15,16] it is not surprising to see further separation and distinction of the types of patients and procedures performed using each method in this comparative cohort study. This study demonstrates that certain thyroid-related pathologies are more commonly and optimally managed using a GA approach, such as extensive substernal and symptomatic goiter, locally advanced or regional thyroid cancer, and complicated reoperative procedures. While substernal goiter may also be treated using LA, in a previous publication, risk for conversion to GA was demonstrated, which was similarly seen in locally or regionally advanced cancer.[1] These data are in agreement with recent reports from others evaluating risk factors for airway compromise in goiter resection,[27,28] complications of substernal thyroid resection,[24,28–30] and thyroid cancer operation,[31–33] all challenging clinical scenarios managed using GA.

Since administration of GA has become safer in recent times, this modality has been utilized safely in patients with comorbidity,[34–36] which is also demonstrated in this report. Overall, few patient-related factors mandate either approach to thyroidectomy. However, an interesting and unique application of LA involves a subset of patients with amiodarone-induced hyperthyroidism (AIT). In this series, all cases of AIT were treated with LA exclusively and comprised 9 of the 11 cases with ASA scores ≥3. Other series addressing thyroidectomy in AIT patients where GA is used have described incidences of mortality related to anesthesia.[36,37] Our opinion is that this subset of patients uniquely benefits from an LA thyroidectomy approach.

Recurrent and Superior Laryngeal Nerve Monitoring

Endocrine surgery literature addresses many methods of nerve identification and monitoring during thyroidectomy that have yet to demonstrate improved nerve injury rates in comparative analyses.[38–43] To prove any given method superior would be a hard task since nerve injury incidence is low,[23] experience counts,[44–48] and many patient- and thyroid-related factors influence outcomes.[49–51]

A patient who is awake and able to phonate allows for immediate feedback to the surgeon and patient regarding the integrity of the speaking voice and pitch. We feel this is the most accurate means of monitoring the voice during thyroid surgery. In this series, we have shown that the LA method is, at the least, not inferior to standard conventional thyroidectomy performed without specific nerve monitoring. There has been concern to those adverse to LA thyroidectomy procedure that an awake patient who is able to move about, speak, and swallow may actually impose increased risk of unintended nerve injury. However, no nerve injury was attributable directly to anesthetic choice in this or previous publications.[1] Thyroid pathology was identified as an important factor in each case of unintended nerve injury, namely, cancer, thyroiditis, and large goiter.

Though difficult to quantify, potential nerve injury may have been reduced in cases performed using LA where feedback of nerve integrity was vital to preserving its function. An identical case performed under GA without specific monitoring may have resulted in nerve damage. Likewise, it is difficult to know if unintended injury might have been avoided in any of the 6 patients in the GA group who experienced temporary or permanent nerve injury if phonation had been possible. More specific proof of the efficacy of nerve monitoring during thyroidectomy using LA would only be possible with a larger number of GA patients.

Outpatient Thyroid Surgery and Management of Potential Delayed Operative Morbidity

Since The Institute of Medicine report on hospital medical errors[52,53] and ongoing pressures for cost containment, further interest has been encouraged in performing LA procedures as outpatients wherever possible in order to maximize patient safety and decrease cost across all specialties of medicine and surgery. Patients as consumers continue to place demands on less invasive methods and the importance of cosmetic results.[54–59] This has sparked interesting debates in the endocrine surgical community with regard to the safety of early discharge and methods of thyroidectomy.[16]

It has become clear that prior barriers to early discharge, such as hypocalcemia, pain, nausea, and vomiting are no longer considered by most clinicians to pose significant risk to ambulatory thyroid surgery patients. These concerns have been addressed in the literature and similarly in our unit.[1,15,16,19,20,60,61] Protocols of calcium prophylaxis with or without vitamin D therapy for high-risk patients have proven effective and safe.[57,62] Likewise, cervical block analgesia[15,63,64] and decreased opioid use in the perioperative period[65] with improvement of associated nausea and vomiting symptoms all contribute to the successful early discharge of patients and decreased readmission rates observed in contemporary outpatient thyroidectomy reports (Table 5).

Early discharge of patients following thyroidectomy is controversial since potentially life-threatening neck hematoma has been documented to occur beyond a short-stay, 6-hour, observation period.[21,66–68] It has been suggested that early discharge of patients may result in increased mortality due to this serious complication occurring outside a hospital setting.[16,66] Many endocrine

Table 5.

Summary of outpatient thyroidectomy series using local or general anesthesia with reported morbidity, mortality, and hospital stay outcomes (n = 2,225)

Report	Number	Anesthesia	RFN	Hypopara	Bleed	Readmit	Death	DC in hours (%)
Steckler, 1986,[11] USA	48	General	0	0	0	0	0	<23 (85)
Marohn, 1995,[12] USA	150	General	P: 1 (0.7)	T: 3 (2.0) P: 1 (0.7)	1 (0.7)	1 (0.7)	0	<23 (97)
Mowschenson, 1995,[13] USA	61	General	0	T: 2 (3.2)	0	0	0	6–8 (61)
McHenry, 1997,[1] USA	71	General	T: 2 (2.8)	T: 8(11.3)	1 (1.4)	1 (1.4)	0	<23 (88)
Samson, 1997,[7] Philippines	809	General, local	T: 19 (2.3)	T: 16 (2.0)	1 (0.1)	0	1 (0.1)	20 (na)
Specht, 2001,[7] USA	21	Local	0	T: 1 (5.0)	1 (5.0)	1 (5.0)	0	<23 (19)
Testini, 2002,[60] Italy	40	General	0	T: 3 (7.5)	0	0	0	<23 (95)
Sahai, 2005,[61] UK	104	General	T: 4 (3.8)	T:2 (2.0)	0	4 (3.8)	0	<23 (100)
Spanknebel, 2005,[1] USA	1,025	Local	T: 20 (2.0) P: 10 (1.0)	P: 1 (0.1)	5 (0.5)	0	0	6 (80)

T: temporary; P: permanent; Hypopara: symptomatic hypoparathyroidism; RLN: recurrent laryngeal nerve; DC: discharge from hospital; na: data not available.

Table 6.
Thyroidectomy reports with time-to-occurrence details for neck hematoma: the importance of duration of postoperative observation and emergency airway intervention

Author, year	Number	Number of hematoma (%)		
		6 hours	7–24 hours	>24 hours
Present study	1,194	6 (75)	1 (12.5)	1 (12.5)
Spanknebel, 2005,[1]	1,025	5 (100)	0	0
Hurtado-Lopez, 2002,[70]	1,131	9 (100)	0	0
Abbas, 2001,[68]	1,268	1 (10)	5 (50)	4 (40)
Burkey, 2001,[66]	13,817	18 (43)	16 (38)	8 (19)
Bergamaschi,1998,[71]	1,192	7 (70)	2 (20)	1 (10)
Lacoste, 1993,[67]	3,008	9 (82)		2 (18)
Shaha, 1991,[69]	600	7 (100)	0	0

surgeons impose a 23-hour observation period or longer in order to assure safe discharge of patients. (Table 5). Furthermore, some suggest that in observing patients for 23-hours, an additional 38%–50% of serious complications otherwise missed with early discharge would be captured, supporting longer hospital stays for thyroidectomy procedures.[16,66] (Table 6). However, emerging data suggest that life-threatening airway compromise or bleeding in fact occurs within the first 6-hours of observation.[1,69,70] It therefore becomes vital to observe patients in a recovery room or monitored setting, as described in this report, in order to recognize and address these issues optimally should they arise. This may also explain the fact that hematoma was not observed beyond 6-hour observation in our series since any signs of swelling were treated early, aggressively, and safely, perhaps avoiding the types of intermediate-delayed hematoma reported by others to occur within a 6- to 23-hour time-period postoperatively (Table 6).

Delayed neck hematoma (>24 hours up to 5 days) was observed in our study and likewise has been reported by others.[21,65–67,71] In a report by Burkey *et al.*,[66] 19% of hematomas requiring therapy occurred beyond 24 hours. It is interesting to note that in the present report, delayed bleeding occurred in GA patients only: an inpatient with coagulopathy and an outpatient due to technical error. Although these occurrences were low, subtle yet important distinctions between the 2 techniques—LA vs. GA—become vastly apparent. These distinctions highlight potential areas of improvement toward the reduction of delayed hematoma and prevention of airway compromise since delayed occurrences of neck hematoma will assuredly take place in an outpatient setting in some cases (Table 6).

First, an awake patient undergoing thyroidectomy using LA is asked to cough and Valsalva, which supplies immediate real-time feedback to the surgeon regarding the integrity and durability of hemostatic control. This is not possible to the same degree with a patient under GA. It is likely that the technical error in the patient with delayed bleed at 5 days may have been noticed using these techniques, which are possible only under LA. Also, particular vigilance on the part of the operating surgeon to secure absolute hemostasis in patients who are likely to be discharged early may occur when an outpatient thyroidectomy program is in place. Furthermore, for both LA and GA patients, we employ a technique whereby the lower strap muscles are left open. This was vital to the prevention of tracheal compression in the case of rapid, delayed bleeding that occurred in an outpatient setting since the patient was able to recognize swelling early and was alleviated of potential airway embarrassment with decompression of blood into the superficial soft tissue planes.

We have shown that outpatient thyroid surgery is feasible and safe in both LA[1] and GA patients when implemented within the context of a mature outpatient thyroidectomy program with procedures performed in appropriately selected patients by experienced, high-volume surgeons with expertise in thyroid surgery. Delayed hematoma in GA patients remains an area for further study and particular caution. It is likely that these criteria applied to similar tertiary centers would meet with similar excellent results.

Cost Associated with Thyroidectomy Using Local or General Anesthesia

In this series, and similar to other reports investigating cost associated with outpatient thyroidectomy,[11–14] we have shown a reduction in ATC for patients undergoing thyroidectomy using the LA method ($2,974) compared with GA ($4,412); $P = 0.006$. Early discharge (6-hour observation) was a significant factor impacting both GA and LA procedures, with a 43% and 37% reduction in ATC per case, respectively, compared with procedures performed with longer hospital stays. Thyroidectomy performed as an outpatient using GA was 14% more costly than procedures performed as outpatients under LA ($3,153 vs. $2,760) and 27% more costly for those staying longer than 6 hours ($5,542 vs. $4,362); $P = 0.023$.

Although outpatient status may contribute to cost containment for thyroidectomy procedures, factors such as operating room utilization and necessary extent of procedures performed are also important areas to explore. ATC per case was significantly impacted by increased overall operating room time associated with GA procedures (180 vs. 120 minutes; GA vs. LA; $P < 0.001$). Room utilization was also less predicable in GA cases, which translated to significantly varied per-minute costs associated with GA procedures (SD: $4.08 vs. $1.95; GA vs. LA; $P < 0.001$). Likewise, more extensive procedures, such as bilateral thyroidectomy and concomitant procedures, also resulted in increased ATC per case for thyroidectomy performed using GA compared with LA; $P < 0.001$.

Interpretation of these data should be tempered with consideration of limitations inherent to the dataset. Surgeon experience has been shown to influence outcomes and associated cost for thyroidectomy procedures[44,47,48] and is not controlled for in this study. Also, since our thyroidectomy program is heavily weighted toward performing procedures using LA, there are fewer GA cases represented in this comparison, which introduces a bias into the calculated weighted averages. Nonetheless, cost associated with LA procedures appears to be lower than those for GA. More work is needed to determine specific areas of focus to improve overall associated cost of thyroidectomy.

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